Laser Technology Development Program

Frank Peri

Presented to the Technology Strategy Team

Hampton, Virginia

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Origins

- In January 2001, a memo from the AA's of Code Y and R requested that GSFC and LaRC jointly respond to three separate actions. These are quoted and listed in their order of appearance in the letter:
  - "and for GSFC and LaRC together to define the plans for working together on areas of mutual interest in laser development in a complementary way."
  - "GSFC and LaRC must define how Centers will cooperate on future lidar competitive opportunities, in order to be able to fully participate in an integrated Agency research and development strategy for lidar technologies."
  - Define "a GSFC/LaRC lidar working agreement as well as a description of your envisioned role in the Agency research and development strategy for lidar technologies/ Laser Development Steering Group."
- In addition, in November 2000, the findings of the Independent Laser Review panel were published which included, amongst others, the creation of a "Space Laser Super Center" managed as a single organization at the NASA HQ level.
- LaRC and GSFC have formed a joint working team, the NASA Integrated Lidar Systems Strategy Team (NILSST), in response to these findings and requests.

Integrated Lidar Systems Strategy Team

HQ Leads:

- Tom Magner, NASA, HQ
- Christyl Johnson, NASA HQ

ESTO:

- Frank Peri, Instrument Program Manager

LaRC Team:

- Upendra Singh, Co-Lead, Head, Electro-Optics and Controls Branch
- Syed Ismail, Science Advisor, Chemistry and Dynamics Branch
- Norm Barnes, Technology Advisor, Laser Systems Branch

GSFC Team:

- Bill Heaps, Co-Lead, Head, Laser and Electro-optics Branch
- Bruce Gentry, Science Advisor, Mesoscale Atmospheric Branch
- Robert Afzal, Technology Advisor, Laser Remote Sensing Branch

LaRC/GSFC Facilitators:

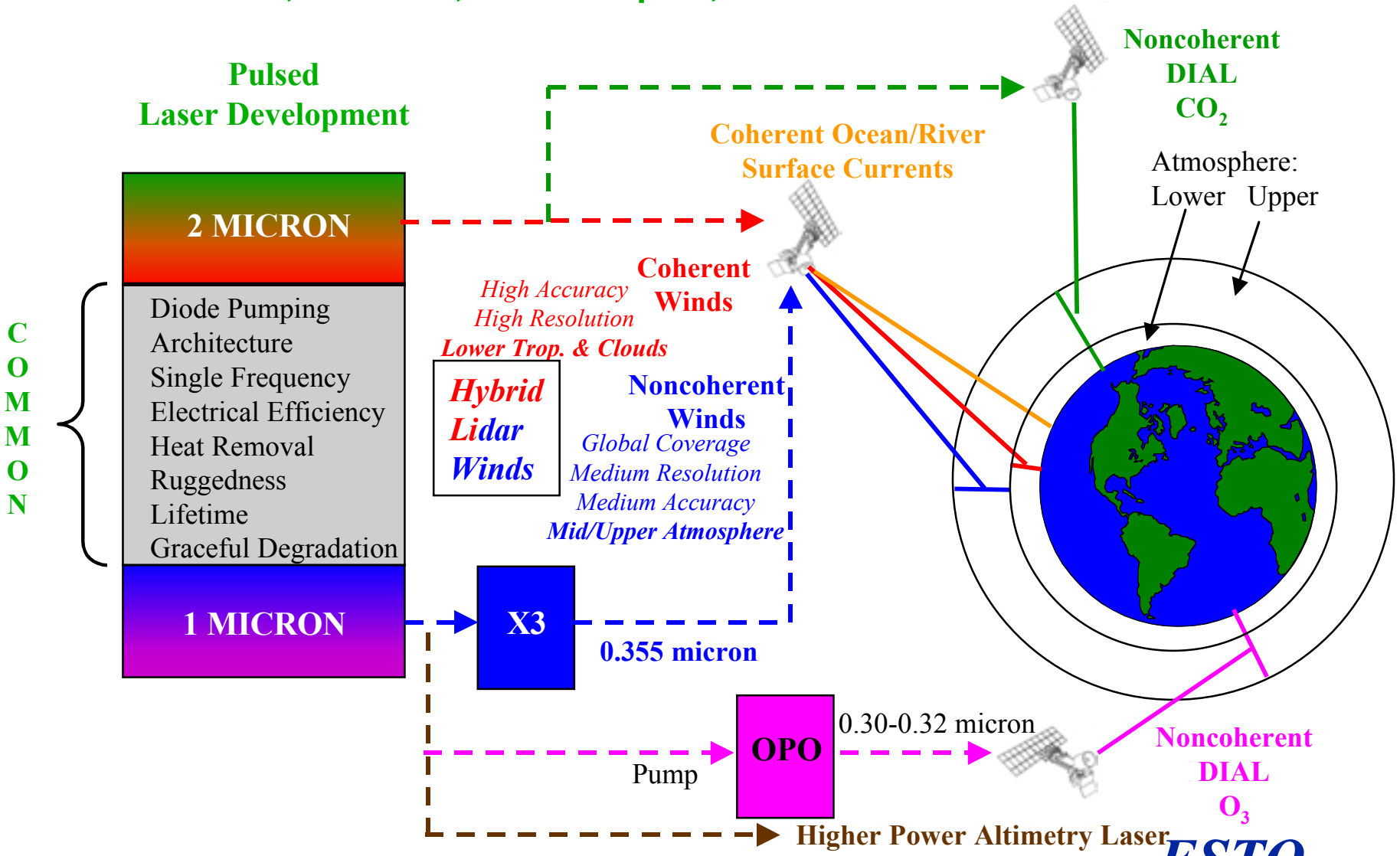
- Steve Sandford, LaRC
- Mary Kicza, GSFC

Laser Technology Program Overview

- Program created out of concern that there are no lasers as active sources for space-based remote sensing that have been space qualified for long-term science measurements.
- Presently, the risks inherent in developing these technologies have been born by science programs. The intention of this new program is to mitigate risks in certain areas so that programs such as IIP can further the maturation of the instruments prior to science infusion. The program will invest in several critical areas:
  - Advancing transmitter technologies to enable ESE science measurements (tropospheric ozone, water vapor, winds, altimetry)
  - Development and qualification of space-based laser diode arrays
  - Advancing nonlinear wavelength conversion technology for space-based lidars

Integrated ESE Lidar Strategy

1 Team, 2 Lasers, 3 Techniques, 4 Desired Measurements



Laser Transmitter Task

Objective

Develop a high-energy, high-efficiency, conductively-cooled, 2-micron pulsed laser

Description of Task

Develop a laser with conductively-cooled laser diodes; develop a thermal and optical simulation of the laser head; design and fabricate a fully conductively-cooled laser head; and design a compact, hardened laser.

Deliverables

Working laser with CC laser diodes; thermal/optical laser head simulation; bonding procedure knowledge; fully CC laser head

Laser Diode Array Task

Objectives

Establish in-house capabilities at LaRC and GSFC to address the issues associated with diode laser array pumps for solid state lidar transmitters. Collaborate with industry and perform specialized testing to ensure technical and commercial availability of laser diodes for pumping of efficient, conductively-cooled, space-qualified, 2-micron solid-state lasers in future NASA missions

Description of Task

Develop laser diode requirements; conduct technical interchanges with laser diode vendors and with the Air Force; procure initial selection of LDs; design, procure, and assemble LD test facility at LaRC; perform initial LD tests and analyses

Roles and Responsibilities

LaRC: Diode Lasers operating at 790-795 nm for pumping 2-micron lasers

GSFC: Diode Lasers operating at 808 nm for pumping 1-micron lasers

Approach

- Define operational, physical, and environmental requirements
- Establish working relationships with Industry and DOD
- Develop in-house characterization and life-time test facilities
- Collaborate and exchange data between GSFC and LaRC
- Provide input to diode laser manufacturers

Wavelength Conversion Task

Objective

Develop wavelength conversion technologies to convert Nd:YAG laser into an efficient, high-energy, tunable, pulsed UV laser in the 250 – 320 nm range, develop injection seeding for wavelength/linewidth control

Description of Task

Develop a high-power OPO/OPA/SFG at 320 nm; develop a stable, injection-seeded OPO cavity for use in a high-power laser; develop a tunable, single-mode CW seed source capable of tuning from 600 nm to 950 nm, frequency doubling NIR fiber laser

Deliverables

CW seed source requirements; 150 mJ OPO/OPA/SFG system, lifetime and stability of non-linear materials, space qualification studies for Fiber lasers

Tropospheric Winds Measurement

Current Situation

- Laser transmitter technologies for application to space-based instruments are not mature enough to begin a formulation activity.
- User community believes that NASA must invest in technologies for laser transmitters.
- Current investments by ESTO are insufficient to ensure successful formulation.
- Establish a technology development activity to show progress towards enabling a space-based tropospheric winds measurement to OMB in support of future formulation activity.

Applicable Technology Programs

- ESTO funding laser technology development program for FY 02.
  - GSFC funded for laser diode arrays and injection-seeding techniques
  - LaRC funded for laser diode arrays and non-linear frequency conversion
- Code R funding Advanced Active Instrument Technology Initiative
  - Focused on broader lidar technology needs
- NOAA earmarks to NESDIS (Periera) and OAR (Hardesty)
- IPO effort lead by Chief Scientist (Mango)
- DoD work ongoing, particularly for aircraft (AF Wright Laboratory-Paul McManamon)

Planning to form team (working group)